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WATER MANAGEMENT AT THE DIRECTORATE LEVEL

Report No. 35
Main Document

December 2000

Water Policy Program

International Resources Group **Winrock International** **Nile Consultants**

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Main Document

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These appendices are individual reports prepared by different departments. They have been bound together in a separate volume for convenience of access.

Executive Summary

Ministry of Water Resources and Irrigation has recognized that traditional methods of distributing water on the basis of water levels will not be adequate for water management in the future.

Agricultural Policy Reform Program, Tranche III, Benchmark C.1: "Main System Management Program Utilization", has been successfully implemented. The water managers are now using a powerful tool for water distribution at the divide locations separating directorates, based on both levels and discharges using telemetry data.

As a first step, the ministry adopted a policy in June 1999 that water distribution among directorates should be based on both water levels and volumetric flows. The ministry adopted a second step to generalize this policy at directorate, inspectorate, and district levels.

In the past the Ministry policy was to distribute water according to a predetermined plan, achieved by monitoring canal water levels, and making adjustments when conditions warranted. This practice was insufficient and magnifies other negative conditions such as water logging or water deficit. The Ministry recognizes the deficiencies inherent in the old system and is determined to implement new policies that will result in proactive water management and improved distribution and management of water. This benchmark will advance this policy reform significantly beyond the first step implemented in June 1999.

The objectives of this policy reform are:

- To implement water distribution based on volumetric flow within directorates and between inspectorates to districts.
- To efficiently use the completed telemetry system in conjunction with manually obtained data to achieve volume-based water management.

To apply this policy reform, a pilot program was established in two directorates, Qena and Sharkiya. There are 19 divide locations separating inspectorates and districts in Sharkiya and 24 in Qena. Twenty flow-measurements were performed by flow-measurement teams in the two directorates, totaling 860 measurements. These measurement results were used to estimate a mathematical formula and hydraulic parameters for each individual site, in order to convert water levels into discharges and daily volumes.

By modifying the telemetry software to accept these formulae, the directorate water manager, who monitors data on a computer screen, can base his decision on available water levels, discharges, and daily volume at each site .

The importance of applying flow based water management utilizing the telemetry data collection real-time system has been verified. Accumulated daily volume passing through a given control structure was used as the major indicator for the purpose of comparison between the two practices

Results prove that the “6 AM.” Water level reading is not a sufficient water management indicator. In Upper Egypt region, if the water engineer depends on the observed “6 A.M.” reading he tends to waste more water than planned, indicating the presence of surplus. While in Lower Egypt directorates, water quotas are either barely matched and some times shortages do exist.

It is recommended to extend the flow-based water management policy in other irrigation directorates. Once the program successfully demonstrates efficient water management at directorate level, it can be implemented throughout the system according to a National water management policy.

Finally, the current benchmark exceeded its predefined indicators since the flow based water management policy addressed sites down to and including the district level, instead of only considering water management at the directorate and inspectorate levels as called for in the benchmark statement.

1. Introduction

The Main System Management (MSM) Project was launched by the Ministry of Water Resources and Irrigation (MWRI), Government Of Egypt (GOE), as a major component of the Irrigation Management System (IMS) Project supported by the United States Agency for International Development (USAID). In the mid 1980's, the Main System Management (Telemetry Project) was being conducted. During the 1990's, project implementation efforts succeeded to monitor water data collected from 800 remote units located throughout the entire national irrigation and drainage network. Remote units transmit water level data to 24 water management offices located in irrigation directorates countrywide, in addition to the master station at Telemetry Main Office in the ministry building in Imbaba. Data is automatically transmitted to the central water management office of the ministry through a computer local-area network.

Throughout the project life, it has been evident that efficient water resources management depends largely on the availability of adequate hydrological data. While, the archiving of long-duration time-series data is required for design and planning purposes, the operation of water resources systems requires data on a real-time basis.

2. Background

Water is a finite resource that is essential for agriculture, industry and for human existence. In arid and semi-arid countries, where water resources are quite limited, challenges for achieving the highest possible water use efficiency are particularly difficult. Efficient water use and proper water management are essential to satisfy the requirements for sustainable development. Efficient water resources management depends largely on the availability of adequate hydrological data. For design and planning purposes, long time-series with high resolution in time and space are required, while for operation of water resources systems, the relevant data should be provided in real-time, i.e. without delay.

Egypt is an arid country, where the average annual rainfall seldom exceeds 200 mm along the northern coast, having 98% of its water resources conveyed through the Nile River. Egypt's share of water resources is determined by treaty to be 55.5 billion cubic meters. Surface irrigation systems are used in most cultivated lands of the Nile Valley and Delta. It has been noted that the water distribution efficiency is low within the system, especially at the local (on-farm) level.

The Ministry of Water Resources and Irrigation (MWRI) aggressively tackling this problem by utilizing most recent technologies in implementing and executing different projects that aims at:

- Conservation Of Nile Water
- Raising The Efficiency Of Water Use
- Improving Performance Of The Water Distribution System

MWRI also realizes the importance of enhancing water distribution policy through the establishment of sustainability measures for those projects. The ministry has recognized that traditional methods of distributing water on the basis of water levels will not be adequate for water management in the future.

The Agricultural Policy Reform Program, Tranche III, Benchmark C.1: "Main System Management Program Utilization", has been successfully implemented. The water managers are now using a powerful tool for water distribution at the divide locations separating directorates, based on both levels and discharges. As a first step, the ministry adopted a policy in June 1999 that water distribution among directorates should be based on both water levels and volumetric flows. The ministry adopted a second step to generalize this policy at directorate, inspectorate, and district levels.

3. Objectives

In the past, the ministry policy was to distribute water according to a predetermined plan, achieved by monitoring canal water levels, and making adjustments when conditions warranted. This practice was insufficient and aggravated other negative conditions such as water logging and salt buildup in the soil. The ministry recognizes the deficiencies inherent in the old system and is determined to implement new policies that will result in proactive water management and improved distribution and management of water. Such policies will allow increased agriculture production while reducing potential soil salinity problems and water losses. This benchmark will advance this policy reform significantly beyond the first step implemented in June 1999.

The objectives of this policy reform are:

- To implement water distribution based on volumetric flow within directorates and between inspectorates to districts.
- To efficiently use the completed telemetry system in conjunction with manually obtained data to achieve volume-based water management.

4. Work Plan Outline

A fifteen (15) month time line, covering the period from September 1, 1999 to December 31, 2000, has been created to facilitate and track implementation. There are 19 divide locations separating inspectorates and districts in Sharkiya and 24 in Qena. A minimum of 20 flow-measurements per site are required, totaling 860 measurements, to be carried out by water-management and flow-measurement teams in the two directorates. These measurement results are used to estimate a mathematical formula and hydraulic parameters for each individual site, in order to convert water levels into discharges and daily volumes.

By modifying the telemetry software to accept these formulae, the directorate water manager, who monitors data on a computer screen, can base his decision on available water levels, discharges, and daily volume at each site (see Table 4.1).

Table 4.1 Benchmark Work Plan

5. Benchmark Accomplishments

The workplan has been successfully accomplished during the benchmark's life span, from September 1999 to December 2000, with the cooperation from the Main System Management (MSM), Sharkiya and Qena Directorates, Water Policy Advisory Unit (WPAU), Monitoring, Verification and Evaluation Unit (MVE), and EPIQ.

1.1 Perform Field Flow-Measurements

The telemetry project provided all irrigation directorates with complete flow-measurement tool sets, trucks, and boats in the early 1990's. This equipment helped directorate flow-measurement teams to replace their traditional measuring techniques with modern ones, facilitating completion of the scheduled program.

The highly qualified and well-trained Sharkiya and Qena flow-measurement teams excelled in their performance while obtaining 860 accurate flow-measurements in 43 locations during an 11-month period. Schematic diagrams of Sharkiya and Qena irrigation networks are shown in Figures (5.1) and (5.2). Flow-measurement site names, types, orders, and number of field measurements are shown in Appendix I.

1.2 Site Preparation Civil Works

Flow-measurement sites should satisfy certain basic requirements, therefore civil engineering works were completed in certain locations including: canal bank pitching, constructing guide steel angles and masonry stairs, refining bank slopes, weeds and obstacle removal, etc.

1.3 Install New Telemetry Sites

Three sites in Sharkiya which were not equipped with telemetry (km. 24 Regulator on Bahr Mowaise, Bahenbay Canal Intake, El-Sady Canal Intake) now have telemetric capacity coordination efforts between the telemetry main office staff and the Sharkiya telemetry team.

Figure 5.1 Sharkiya Directorate Schematic Diagram

Figure 5.2 Qena Directorate Schematic Diagram

1.4 Training Courses in Flow-Measurement Techniques

A training course was given to water-management and flow-measurement teams in Qena and Sharkiya. The first session was held at Qena during April 17-20, 2000, and the other in Sharkiya during April 29-30, 2000. The course syllabus included an introduction, six chapters, tables, illustrative graphs, and solved examples (see Appendix V). It was an interactive course with a lot of discussion and experience exchange. It also had a practical component that included detailed instruction in flow-measurement equipment and on-the-job training. Feedback from the trainees was excellent and their flow-measurement techniques have greatly improved. This improvement was clear when the flow-measurement results were reviewed.

1.5 Coordination Meetings and Follow-Up Field Visits

Ten coordination meetings and follow-up visits were conducted, five in Qena and five in Sharkiya. During these meetings agreement was reached regarding flow-measurement site names and locations, detailed work plans, directorate flow-measurement team tasks and coordination requirements between the two directorates and the Telemetry Main Office. Reports from these meetings and visits are shown in Appendix II.

1.6 Review Results of Flow-Measurements

The telemetry main office team has reviewed the results of field flow-measurements done by directorate flow-measurement teams month after month during the benchmark lifetime. Statistical analysis showed that most of these results were accurate and correlated to their mathematical formulae with a ratio ranging from 95% to 98%. Allowances were made for human error.

1.7 Identify Mathematical Equation Types and Estimate Hydraulic Parameters

Discharge measurements were plotted against the corresponding water levels. Using the curve fitting technique and least-squares method, the best curve was obtained and used to estimate the unknown parameters of the hydraulic equations. Water managers in Egypt commonly use four types of hydraulic equations that convert water levels into discharge. These four types may be summarized as follows:

1.7.1 Abac: (Water head and gate opening equation)

$$\mathbf{Q = A \,.\, Gop \,.\, (US - DS)^{0.5} + B}$$

This equation was derived from the famous equation of fluid flow through a submerged orifice, and flow under a sluice gate. The telemetry has no sensor to measure gate opening in a real-time basis, so this equation could not be used with the real-time telemetry data.

1.7.2 Nomogram: (Water depth and reach slope equation)

$$\mathbf{Q = A \,.\, (DS - FL)^{1.5} \,.\, (DS - Next)^{0.5} + B}$$

This equation was derived from Chezy's formula of uniform flow in open channels; and depends on both the downstream water level of the irrigation structure and the upstream water level at the next gauge. This method was successfully used by the telemetry. If the appropriate hydraulic conditions are present within a canal reach, and the next gauge is equipped with telemetry, this method gives acceptable accuracy.

1.7.3 Weir: (Free-flow over weir equation)

$$\mathbf{Q = A \,.\, (US - Crest)^{B}}$$

Where a weir exists, this equation is considered to be more accurate than others. It is accepted if the submergence ratio between the upstream and downstream water head above crest levels does not exceed a certain known value. This value should not exceed 0.4 in sharp-crested weirs (Fayoum type), or 0.85 in broad-crested standing wave weirs.

1.7.4 Rating Curve: (Downstream water depth equation)

$$\mathbf{Q = A \,.\, (DS - FL)^{2} + B \,.\, (DS - FL) + C}$$

Based on many applications, it was found that a second order polynomial is an acceptable mathematical form to express the relation between downstream water depth of the irrigation structure and discharge.

Where:

Q = Discharge (m^3/s)

Gop = Gate opening (m, or number of links)

US = Upstream water level of the irrigation structure (m)

DS = Downstream water level of the irrigation structure (m)

FL = Floor level of the irrigation structure (m)

Next = Next site upstream water level (m)

Crest = Weir crest level (m)

A, **B**, and **C** = Constants generated from curve fitting.

1.8 Modify, Install, and Test Telemetry Software Dedicated to the Benchmark

A basic water management indicator is the flow through key irrigation network control structures within the local directorate water systems. Another important indicator is that used by decision makers at the General Irrigation Directorate to monitor accumulated daily flow volumes, in order to match flow volumes with planned water quotas. In order to attain efficient management, the water manager should provide directorate decision makers with instantaneous flows on an hourly basis and up-to-minute accumulated flow volumes for any given day.

A new module for flow-based water management (FBWM) was designed and implemented as a tool for decision makers at the directorate level. The flow-based module was incorporated to strengthen the module management system of the telemetry DMS with both flow and accumulated volume decision indicators. The FBWM is an add-in to the new version of the telemetry software, making the telemetry software a typical Decision Support System with major components being a data management system (DMS), a model management system (MMS), and a graphical user interface (GUI). Fig. (5.3) shows the system analysis of the FBWM telemetry system as an integral component.

The DMS imports basic data provided by the telemetry communication network, in addition to issuing daily, hourly, monthly, and annual reports. The MMS analyzes basic water data to provide decision makers with water management indicators. The GUI is the interface between the user and the DMS that allows the user to input, import, and analyze telemetry data and preview and/or print various reports.

The FBWM is installed and running on personal computers, provided by the telemetry data management system (DMS), in the Qena and Sharkiya General Directorates. It utilizes hourly telemetry water data to provide accumulated daily water volumes and instantaneous flows on an hourly basis. The FBWM accepts the entry of flow parameters for four types of flow equations, imports telemetry data, incorporates flow formulae, and issues hourly and daily flow reports.

1.9 Training Courses in Telemetry Software Utilization in Water Management

A training course was given to water-management teams in Qena and Sharkiya. The first session was held at Qena from Oct. 30 - Nov. 1, 2000, and the other in Sharkiya from Nov. 13 - 14, 2000.

The training syllabus included:

- Flow-based water distribution concepts.
- Different flow formulae (variables/parameters).
- General features of telemetry software.
- Importing and archiving telemetry data.
- Entering flow parameters and hydraulic data.
- Previewing and printing hourly flow reports.
- Previewing and printing daily flow volumes reports.
- Case Study: “The Implementation of Daily Flow Volumes”.

6. Utilizing Telemetry System
In Flow-Based Water Distribution

1.10 Water Distribution

The MWRI is the sole authorized organization for water allocation and distribution among various users and sectors. The main responsibility of the ministry is to develop and implement the annual irrigation plan. In order to match the planned water quota with the actual water delivery, the ministry has to control an extensive irrigation network of canals and drains.

In order to control and manage the expanded irrigation and drainage network, water allocation and distribution is being performed at three levels:

1) National level represented by the entire irrigation sector within MWRI;
2) Regional level represented by the two regions, Upper and Lower Egypt;
3) Local level represented by 26 irrigation directorates.

Irrigation directorates are in turn divided into inspectorates that are then divided into small irrigation districts.

The efficiency of water distribution on the National level is an integration of the efficiencies at the local levels. That implies that water distribution at the local levels should be given great attention by decision makers at the Regional and National levels. The Central Directorate at MWRI headquarters is in charge of setting the water allocation and distribution plan. It performs the necessary calculations based on available data on crop pattern, crop water requirements and climatic data and hence determines each directorate's share of expected Nile water supply.

Water is distributed among the directorates based on flows, while at the local and lower levels, water is diverted based on preset levels at upstream and/or downstream control structures. Historically the common practice was to assess the actual water delivery based on the manual readings taken only once a day at "6 AM". This has two drawbacks:

1) The matching between planned and actual daily flow volumes are based on a wrong assumption that water levels are constant throughout the day;
2) Manual readings are subject to human errors and in some cases biasness.

This report presents a case study for verifying ‘flow based water distribution policy” at the directorate level. Emphasis is made on the importance of real-time data in providing a more accurate and efficient water management strategy, through the introduction of a more responsive and automated water management approach.

1.11 Main System Management Project

The MWRI launched the Main System Management (MSM) project to implement a real-time (telemetry) data acquisition and control system. The MSM project was established in order to provide water distribution managers at the national, regional, and local levels with accurate water level data that is continuously updated to reflect the current conditions of the irrigation network.

The project was designed to help decision makers efficiently achieve the best distribution of the limited water supply and realize the best operation of the irrigation system. Providing system managers and operators with real-time knowledge of the status of the irrigation system so that they could match the estimated crop water requirements with adequate and timely supply of water without waste or shortage in the system does that. The MSM project collects water level, regulator gate position, pump station on/off status, and water quality data throughout its network of about 800 sites covering the entire irrigation system from Lake Nasser to the Mediterranean sea. Most of the telemetry sites report water level on a real-time basis (every 15 seconds), while about 20% of the sites’ data is updated every two hours.

The project was implemented in two phases. The first was initiated in 1989 to provide meteor-burst communication for 200 remote data collection platforms (DCP’s), and 22 directorate submaster stations. The second phase started in1992 to provide the voice and data communication system (VDCS) with data from 800 remote terminal units (RTUs). This is a radio-based communication system with capabilities to provide voice communication, remote data collection, and canal automation. The telemetry subsystem is allocated to irrigation directorates to support operational responsibilities over irrigation structures and canals within its geographical borders.

The DMS of the telemetry system provides convenient access to centralized data storage of consistent and accurate data. The data is used to generate daily, monthly, and annual reports. The telemetry system is used to distribute those reports to water distribution operators and managers. The telemetry system provides decision makers at all levels of the water management process with basic water distribution indicators and provides historical data for planning purposes.

1.12 Case Study And Application

It was decided to investigate the effectiveness of using the continously recorded water level data, hourly instantaneous-flow rates, accumulated daily-flow volumes as major indicators for applying flow-based distribution policy. Two directorates were chosen to represent a pilot program to apply the flow-based water distribution policy. The study focused on key sites within Qena and Sharkiya irrigation directorates. The Qena directorate represents upstream water users in Upper Egypt, while the Sharkiya directorate represents end users in the Lower Egypt Region. Fig. (5.2) and Fig. (5.3), show schematic diagrams for the canal systems at Sharkiya and Qena directorates, respectively.

Two sites where selected within the Sharkiya Directorate, Abou El- Akhdar Intake and Mashtoul Wier . Abou El Akhdar is the intake regulator for Abou El-Akhdar canal. This canal takes its water off Bahr Mowais canal which, in turn, offtakes water from El Rayah El Tawfiky, one of the main distributary canals fed from the Upstream Delta Barrage. Abou El Akhdar Intake controls water serving 29200 feddans. Mashtoul weir serves as a heading-up structure downstream from the Bahr Mashtoul canal intake. Bahr Mashtoul canal is upplied from the Bahr Mowais Canal. Mashtoul intake controls water to serve 42692 feddans.

Two key sites where selected within the Qena Directorate, Asfoun and Kallabya Intake Regulators. Both sites are critical since they control water flowing into Asfoun and Kallabya distributary canals. Asfoun canal serves an area of 68870 feddans, while Kallabya canal serves an area of 174515 feddans. The two canals end within the Qena directorate, hence all water passing through them are consumed inside the directorates. This means that, unless the water manager uses only the pre-planned water quota, excess water will be wasted within the directorate.

Water levels downstream from those structures are monitored by the MSM communication system. They are recorded on an hourly bases for VDCS sites and every two hours for MB sites and are sent to the regional and central water distribution authorities. The “6 AM” water levels downstream of the structures are still being used to calculate the flow volume delivered through them. The irrigation engineers perform the delivery of the daily planned flow volumes through the regulator or wier by setting the upstream and/or downstream water levels to a predefined level. In order to identify the significance of introducing flow volumes as a water management indicator, the accumualted daily flow volumes, calculated using the traditional “6 A.M.” readings, were compared with those volumes calculated automatically from the 12 or 24 daily telemetry readings. The comparison was done using data for June and July, 2000. This period represents the high water-requirement season.

Four sets of data, one for each structure, were used in this study. The down-stream rating curve flow equation, which was calibrated within the Tranche IV, Benchmark C.3 of the Agriculture Policy Reform Program, was used on all four sets of data in order to maintain consistency in the comparisons. Fig. (6.1) shows the comparison between observed “6 AM” downstream water level and telemetry provided continous hourly water levels for Abou El-Akhdar regulator for the period July 15 - 20, 2000. The figure also shows within-the-day variation of the telemetry readings. Fig. (6.2), shows the comparison for daily flow volumes.

It can be seen that the telemetry recorded levels are consistently lower than the daily observed “6 A.M.” readings. The telemetry system provided the actual within-the-day hourly variation in water levels downstream from Abou El-Akhdar, while the observed data did not even show across-the-day variation. Telemetry data varied in the range of 6 Cms in the 5-day period. Accumulated daily flow volumes calculated using traditional “6 AM” practice proved to be consistently lower than those exhibted by the telemetry.

In general, one can see that actual daily flow volume passing through Abou El-Akhdar was lower than the planned flow volumes. This indicates a deficit for to the water engineer responsible for water management at the directorate and/or inspectorate levels. The water engineer will, in fact, face a water shortage problem due to the misleading “6 Am” reading. The same trend can be observed at the Mashtoul wier for the same period of time. Although telemetry levels downstream from the Mashtoul wier had more variation than the levels observed, the average daily levels were close to the “6A.M.” daily level. Therefore, no significant differences in daily flow volumes can be seen, see Fig. (6.3) and Fig. (6.4).

The Qena directorate, Figs. (6.5) and (6.6) for the Kallabya intake regulator, and Figs(6.7) and (6.8) for the Asfoun intake regulator shows a different trend for the period from June 1-5, 2000. Variation of the telemetry levels in the range of 5 cms in Asfoun canal were observed. Even though that represents a small variation in the actual telemetry readings, the actual flow volume released at Kallabya is much more than planned. The accumulated daily flow volumes calculated using telemetry data were consistently higher than those calculated using the “6 AM” observed data. For the Kallabya canal intake, actual flow volumes were 10% higher than planned. The water engineer in the Qena directorate might be have no incentive to save water since the canal ends within the directorate’s boundaries and he is an upstream user. For the 5-day period tested, a total volume of one million cubic meters of water in excess of the plan was delivered and was actually recorded by the telemetry system.

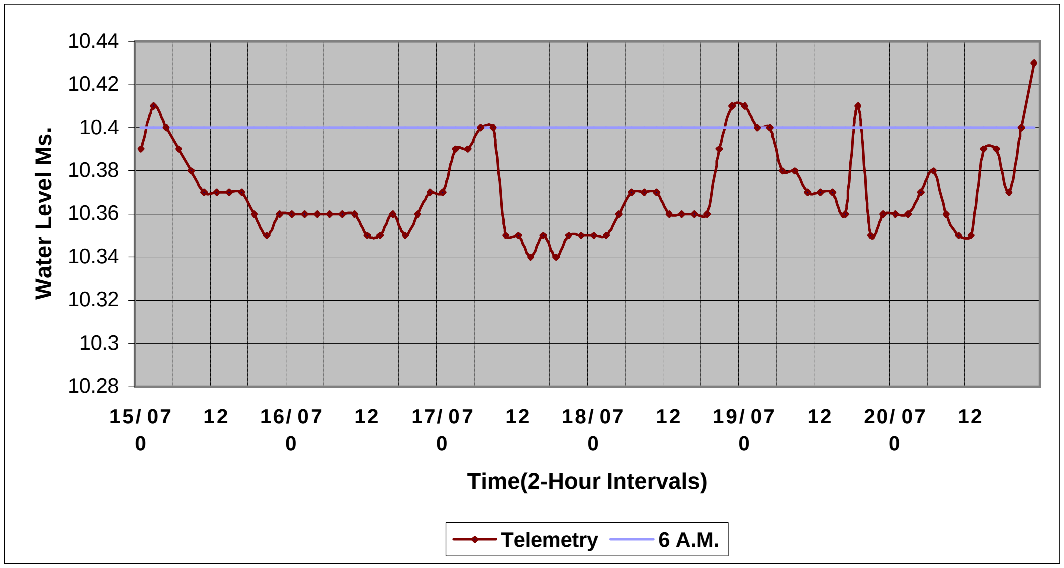


Figure (6.1): Telemetry Recorded Water Levels Versus "6:00 A.M." Water Level, Downstream Abou El-Akhdar Intake

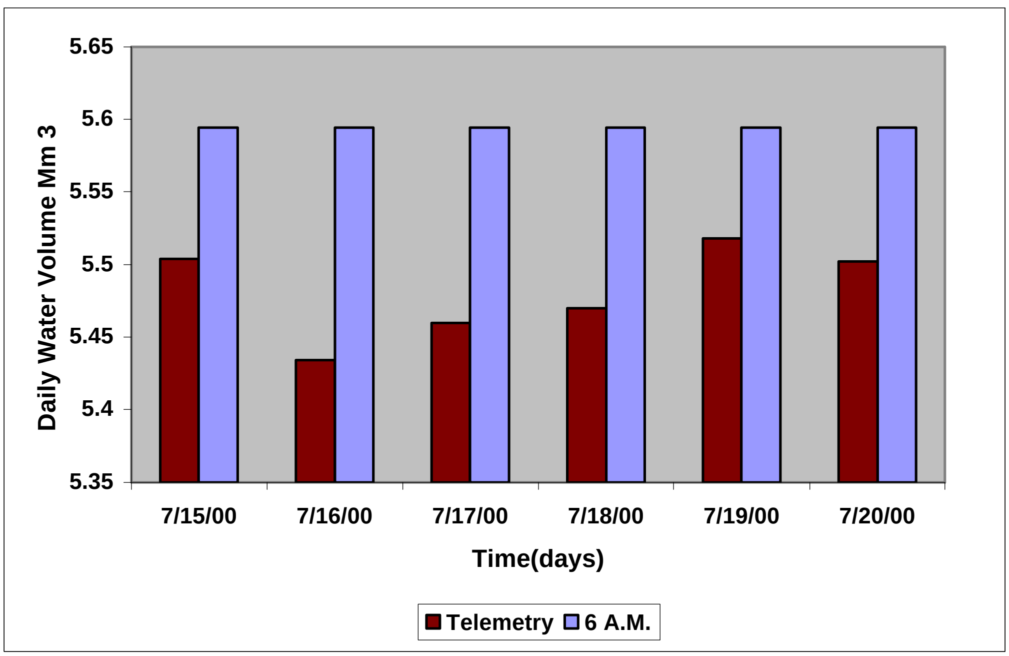


Figure (6.2): Daily Water Volumes Calculated Based on Telemetry Continuous Water Levels, Versus Volumes Calculated Based on "6 A.M." Water Level; at Abou El-Akhdar Intake

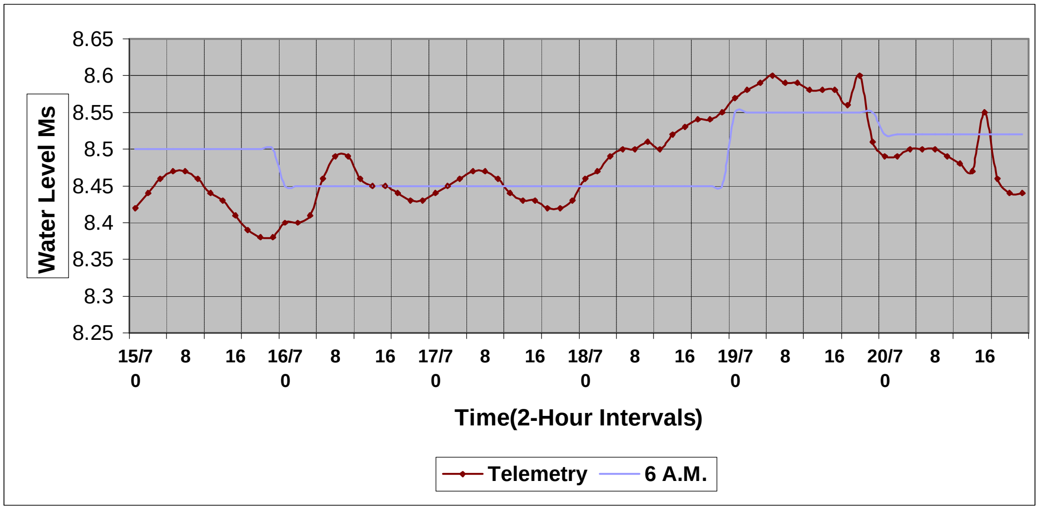
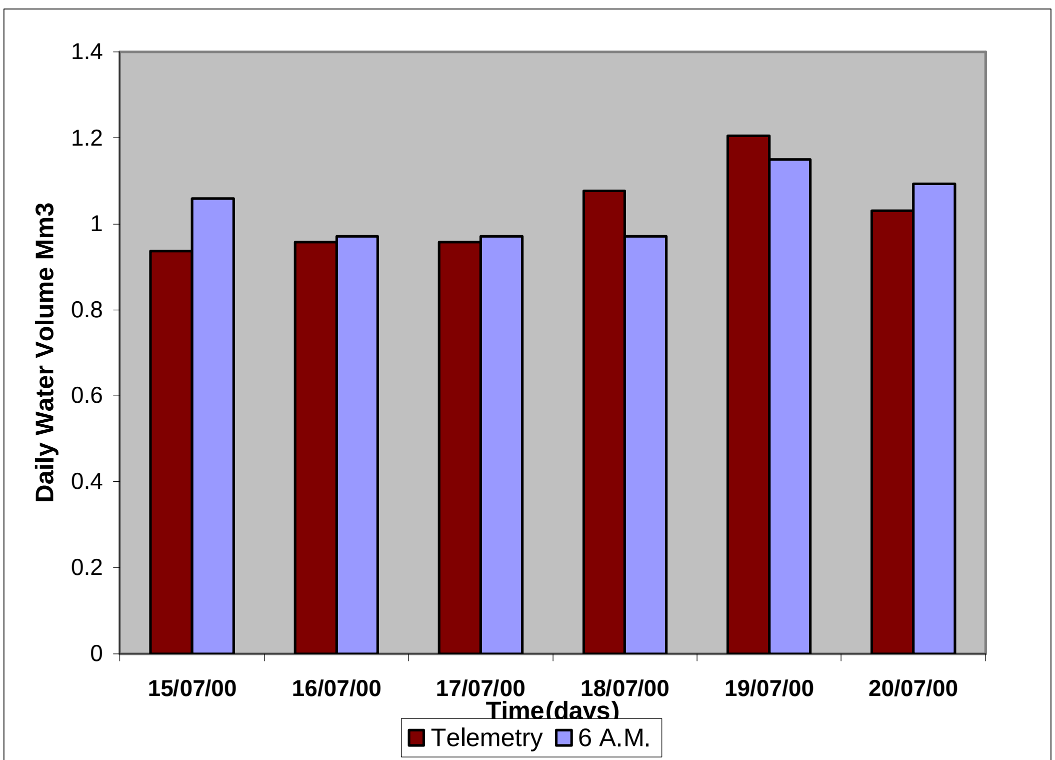


Figure (6.3): Telemetry Recorded Water Levels Versus "6:00 A.M." Water Level, Downstream Mashtoul Weir



Continuous Water Levels, Versus Volumes Calculated Based on

"6 A.M." Water Level ; at Mashtoul Weir

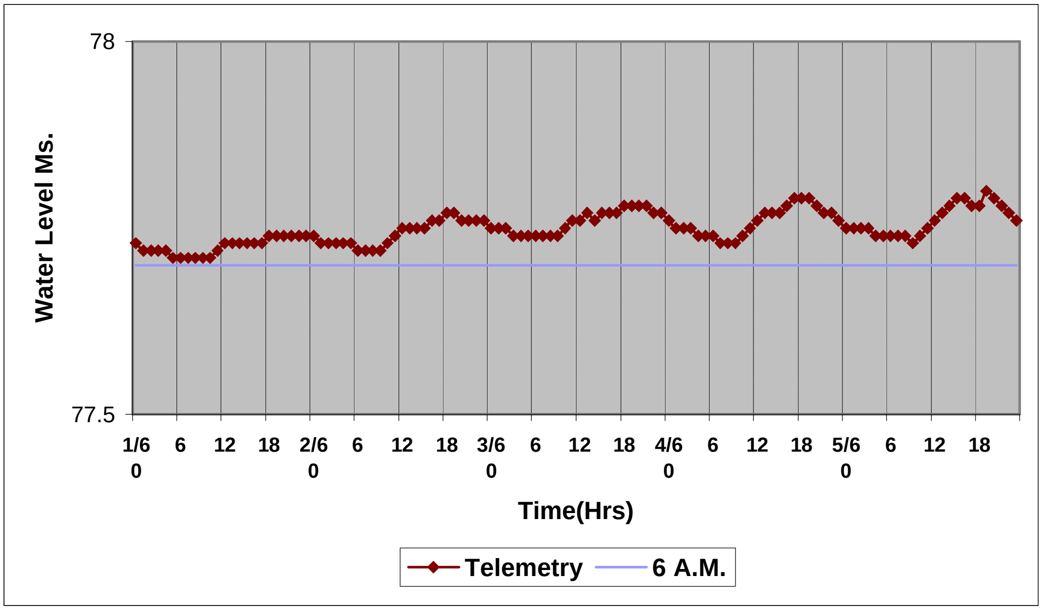


Figure (6.5): Telemetry Recorded Water Levels Versus "6:00 A.M." Water Level, Downstream Kalabya Intake

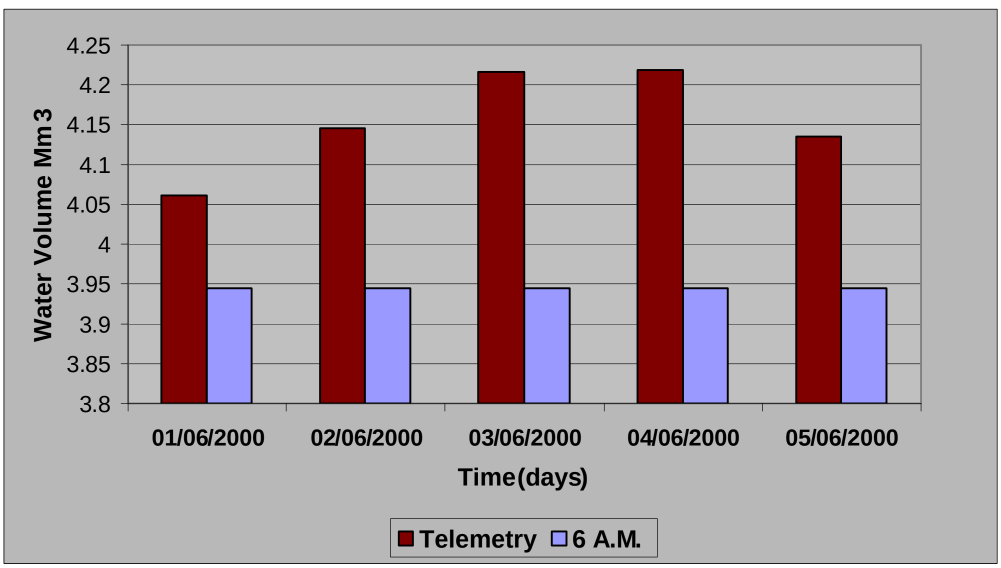


Figure (6.6): Daily Water Volumes Calculated Based on Telemetry Continuous Water Levels, Versus Volumes Calculated Based on "6:00 A.M." Water Level ; at Kalabya Intake

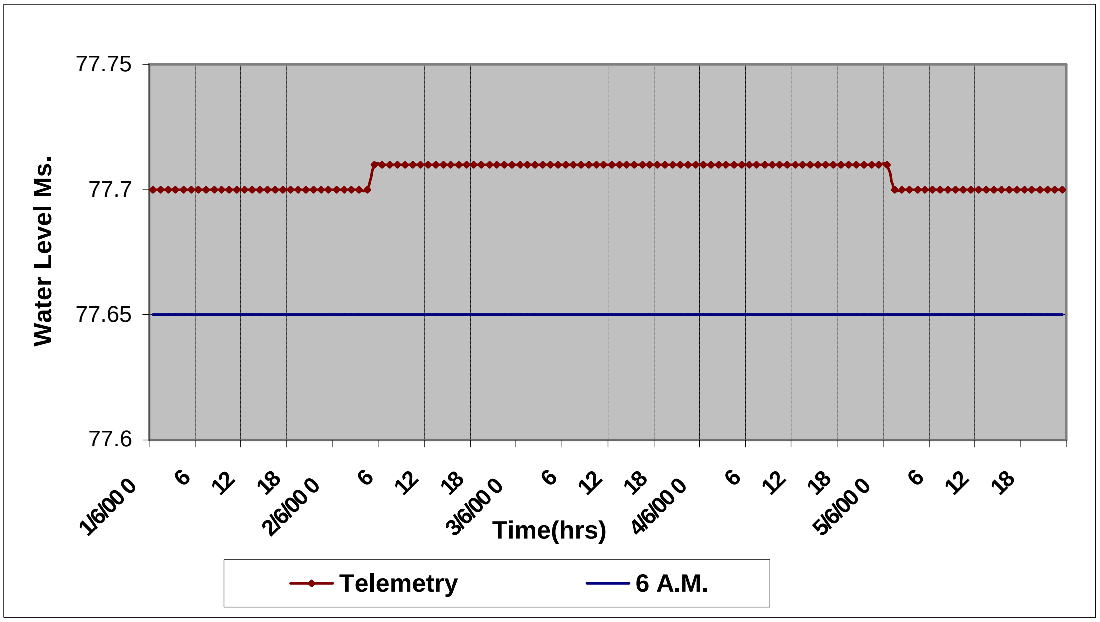


Figure (6.7): Telemetry Recorded Water Levels Versus "6:00 A.M."

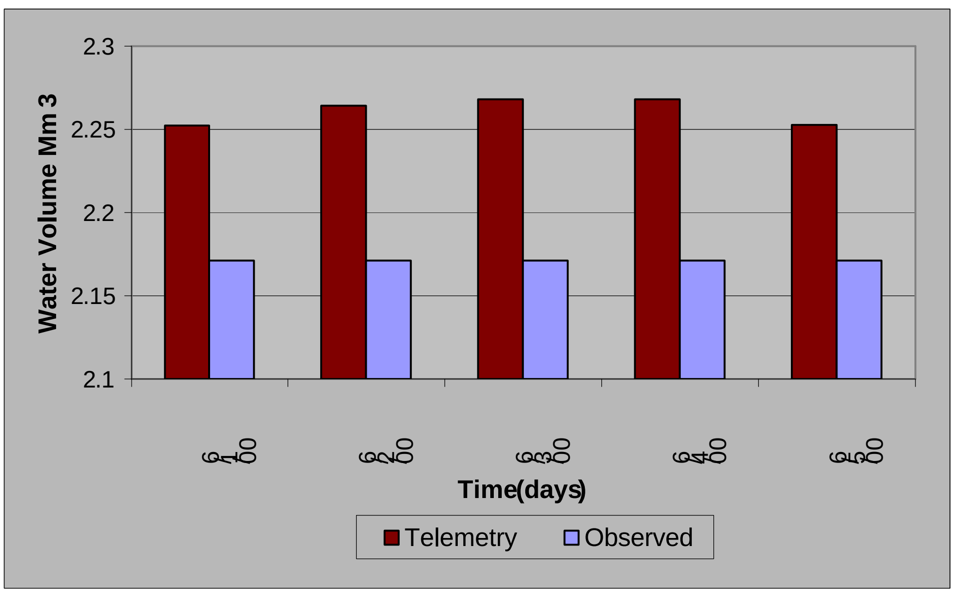


Figure (6.8): Daily Water Volumes Calculated Based on Telemetry Continuous Water Levels, Versus Volumes Calculated Based on "6:00 A.M." Level, at Asfoun Intake

1.13 Conclusions And Recommendations

This study was intended to verify the importance of applying flow-based water management utilizing the telemetry data collection real-time system. The study shows the advantage of applying flow-based water management over the traditional level-based distribution practice. Accumulated daily volume passing through a given control structure was used as the major indicator for the purpose of comparison between the two practices. The study was applied on four telemetry sites, two in Qena and two in Sharkiya. The Qena directorate water distribution policy is supervised by the Regional Directorate of Upper Egypt, while that of Sharkiya is supervised by the Regional Directorate of Lower Egypt.

The study shows that the utilization of telemetry data to provide hourly flows and accumulated daily volumes provides a reliable automated water management capability. Since the actual telemetry water level readings suggest the presence of within-the-day variation, the water manager can update his plan on an hourly basis. Results prove that the "6 AM" water level reading is not a sufficient water management indicator. In the Upper Egypt Region, if the water engineer depends on the observed "6 A.M." reading, he tends to waste more water than the planned quota indicating the presence of surplus. In the Lower Egypt directorates, water quotas are barely met and some times shortages occur.

The study recommends the application of flow-based water management policy in other directorates. It also recommends that the telemetry software be fed by additional indicators to provide further analysis of the real-time data which will help decision makers update their plans on a more timely basis. More descriptive water balance indicators could be incorporated in order to give the decision makers a quick and visual representation of the actual status of levels and flows for canals.

The study reported the on site flow relationship at Qena and Sharkiya directorates in order to demonstrate:

- The ability of the telemetry software to produce accumulated daily flow volumes utilizing telemetry levels reported on real-time bases.

- A significant improvement in water management by shifting from level-based to flow based policy.
- The value of combining real-time data with the 6 AM water level values of the traditional practice to develop a more effective flow-based water management policy,

The study recommends extending the flow-based water management policy in other irrigation directorates. It also concludes that, once the program successfully demonstrates efficient water management at the directorate level, it can be implemented through a national water management policy.

7. Year 2001-2002 Time Frame

The following activities will be implemented in all other ministry directorates:

- Each directorate will establish a flow measurement team.
- Sites that separate inspectorates and districts inside each directorate will be selected.
- Implement 20 measurements per site to determine hydraulic parameters and relations between levels and flows.
- District staff will be trained to install the required telemetry software to provide both water level and volumetric flow at each site.
- Program implementation is scheduled for 15 months, from March 1, 2001 to June 30, 2002 (see Table 7.1).
- Cost estimate, to implement the program, is shown on Table (7.2). This amount should be allocated in order to achieve the target program.

Table 7.1 Timeline Frame for Expanding Water Management at the Directorate Level to All Directorates

Table 7.2 Cost Estimate of Future Work

8. Policy Statement

A ministerial decree has been issued and distributed mandating that water management inside these two irrigation directorates be based on volumetric flow, and that water management in the irrigation system will be volume-based starting in 2002. A copy of the decree is attached to this report.

Arab Republic of Egypt

Minister of Water Resources and Irrigation

MINISTERIAL DECREE

No. 450 For Year 2000
Date 3 / 12 / 2000

Minister of Water Resources and Irrigation
* According to the law of civil workers of the country issued by law 47 for year 1978.
* And, the law of irrigation and drainage No. 12 for year 1984.
* And, based on the memorandum of the Water Strategies Unit.
* It is agreed upon the following.

Article 1:
General Irrigation Directorates, with the cooperation of Telemetry Directorate, will implement a program for flow-measurements, calibrations and mathematical equation derivation which will be put in the computer systems of these Directorates. This will be done for the divide locations that separate inspectorates and districts from each others in a way similar to that followed in Qena and Sharkiya irrigation directorates.

Article 2:
Payment, for this program will be available from cash transfer delivered to the Ministry according to the implementation of Policy Reform Programs Benchmarks.

Article 3:
Starting from July 1st, 2002, water distribution inside Irrigation Directorates will be based on volumetric flows, not only on water levels, for the divide locations that separate inspectorates and districts. Water quantities passing through these locations, will be computed from discharge based on the available telemetry daily 24 hours data.

Article 4:
This decree must be applied by the concerning administrations.

Minister
of Water Resources and Irrigation

Dr. Mahmoud Abou Zeid